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STUDIES ON GENETIC DIVERSITY IN BRINJAL (*SOLANUM MELONGENA* L.)

V. Silambarasan, R. Eswaran*, N. Senthilkumar, P. Thangavel and S. Thirugnanakumar

Faculty of Agriculture, Annamalai University, Annamalainagar-608 002 (Tamilnadu), India.

Abstract

Fifty genotypes of brinjal (*Solanum melongena* L.) was studied for twelve traits to identify genetically diverse genotypes, for the use in cross breeding programme. Analysis of variance revealed significant differences among the genotypes for all the traits of interest. The genotypes *viz.*, VR-2, JBH-3 and Utkalkeshari were called out as elite genotypes, based on *per se* performance. Clustering of 50 genotypes by utilizing the Mahalanobi's D^2 statistic, grouped the genotypes into as many as seven clusters. Cluster VII encompassed of with as many as 21 genotypes. Maximum inter-cluster distance was observed between cluster VI and VII. Cluster VI showed earliness coupled with high number of fruits per cluster and comprised of four genotypes. The genotypes gathered in these groups may be utilized in cross breeding programme to evolve high yielding but early lines and/or hybrids. The intra-cluster distance was maximum among the genotypes constelled with the Cluster VII. These genotypes may be utilized as parents in evolving iso-responsive lines and/or hybrids.

Key words: Brinjal, Mahalanobi's D^2 statistic, Group constellation.

Introduction

Brinjal (*S. melongena* L.) is a true diploid and possess 24 chromosomes. It belongs to the family solanaceae. It is termed as egg plant. It is native of India. It is the most common and popular vegetable in India. It is being extensively grown in Bangladesh, Pakistan, China and Philippines. It is cultivated by small and marginal farmers and referred to as poor man's vegetable. It is cultivated throughout the year. Brinjal fruits are the good sources of calcium, phosphorus, iron and vitamins. The fruits also contain the essential amino acids *viz.*, arginine, histamine, lysine, tryptophane, phenylalanine, tyrosine, methionine, cysteine, threcnine, lucine and valine. Fruits are used as cardio tonic, laxative and reliever of inflammation. Dry shoots of brinjal, are used as fuel in rural areas. It is an often-cross pollined crop (Gobu *et al.*, 2017). A large diversity exist in brinjal (Ullah *et al.*, 2014). Knowledge on genetic diversity, its nature and degree would be useful for selecting the suitable donors for cross breeding programme. Multivariate analysis (D^2 statistic) developed by Mahalanobis (1936) has been found to be a potent tool for measuring genetic diversity (Rao, 1952).

***Author for correspondence :** E-mail : eswargene@gmail.com

Material and Methods

Fifty genotypes of brinjal (*S. melongena* L.) collected from different eco-geographical regions and maintained with NBPGR (New Delhi), NGO (Dindigul), IIUR (Varanasi) and VNMKV (Parbhani) were obtained and studied for the genetic divergence (Table 1). The investigation was carried out at the Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India. The seeds of genotype were sown in separate beds and covered with soil and sprinkled with water, regularly. The seedlings were transplanted in the main field 42 days after sowing, with a spacing of 75×60 cm, in three rows plots of six meter length. The experiment was laidout in randomized lock design, replicated twice.

Recommended agronomic practices and need based plant protection measures were judiciously followed. Observations were recorded on 12 quantitative traits *viz.*, X_1) Days to first flowering, X_2) Plant height at maturity,

Table 1: List of fifty brinjal genotypes used in the study.

S. No.	Name of the genotype	Place of collection
1	ICO 216264	NBPGR, New Delhi
2	ICO 216794	NBPGR, New Delhi
3	ICO 241678	NBPGR, New Delhi
4	ICO 316294	NBPGR, New Delhi
5	ICO 329327	NBPGR, New Delhi
6	ICO 334660	NBPGR, New Delhi
7	ICO 334729	NBPGR, New Delhi
8	ICO 336474	NBPGR, New Delhi
9	ICO 344674	NBPGR, New Delhi
10	ICO 354727	NBPGR, New Delhi
11	ICO 354749	NBPGR, New Delhi
12	ICO 355370	NBPGR, New Delhi
13	ICO 361838	NBPGR, New Delhi
14	ICO 373485	NBPGR, New Delhi
15	ICO 374777	NBPGR, New Delhi
16	ICO 382587	NBPGR, New Delhi
17	ICO 383119	NBPGR, New Delhi
18	ICO 394902	NBPGR, New Delhi
19	ICO 398820	NBPGR, New Delhi
20	ICO 411485	NBPGR, New Delhi
21	ICO 422586	NBPGR, New Delhi
22	ICO 427008	NBPGR, New Delhi
23	ICO 427029	NBPGR, New Delhi
24	ICO 545862	NBPGR, New Delhi
25	ICO 545871	NBPGR, New Delhi
26	ICO 545916	NBPGR, New Delhi
27	Whitish blue and ripped brinjal	NGO, Dindigul
28	Venyutha brinjal	NGO, Dindigul
29	Namakkal brinjal	NGO, Dindigul
30	Utha brinjal	NGO, Dindigul
31	Udumalai brinjal	NGO, Dindigul
32	Udumalaisamba brinjal	NGO, Dindigul
33	Vellore mullukathiri	NGO, Dindigul
34	Dindugal kathiri	NGO, Dindigul
35	Brinjal thorn	NGO, Dindigul
36	Arkakusumakar	NGO, Dindigul
37	CVK Sirukkaraisivappu	NGO, Dindigul
38	Udavai green brinjal	NGO, Dindigul
39	Pusa upkar	IIVR, Varanasi
40	BH-2	IIVR, Varanasi
41	Utkalkeshari	IIVR, Varanasi
42	Utkalijyoti	IIVR, Varanasi
43	JBH-3	IIVR, Varanasi
44	VR-2	IIVR, Varanasi
45	DMU-1	IIVR, Varanasi
46	KKM-1	IIVR, Varanasi
47	Punjab Sadaarhar	VNMKV, Parbhani
48	PBNP-1	VNMKV, Parbhani
49	PBNP-5	VNMKV, Parbhani
50	PBNP-6	VNMKV, Parbhani

Table 2: Analysis of variance for twelve characters in fifty genotypes of brinjal.

Source of variation	df	Days to first flowering	Plant height	Number of branches per plant	Number of flowers per clusters	Number of fruits per clusters	Days to first harvest	Days to last harvest	Number of fruits per plant	Fruit lenght	Fruit breadth	Average fruit weight	Fruit yield per plant
Total sum of square	14	20.400	68.289	2.257	1.315	0.553	30.53	192.105	77.657	8.279	653.338	653.338	1002488
Replication	2	523.931	1393.160	4.0278	2.144	0.819	789.531	3668.045	135.852	13.122	488.742	488.7425	503356.2
Genotype	49	22.653**	101.76**	6.534**	3.82**	1.61**	31.56**	296.04**	224.70**	24.08**	1940.74**	1940.74**	2995901**
Error	98	8.998	24.511	0.0836	0.043	0.017	14.523	69.198	2.944	0.278	12.996	12.996	15967.92

Table 3: Mean performance for twelve traits of brinjal genotypes.

Genotypes/ Characters	Days to first flowering	Plant height	Number of branches per plant	Number of flowers per clusters	Number of fruits per clusters	Days to first harvest	Days to last harvest	Number of fruits per plant	Fruit lenght	Fruit breadth	Average fruit weight	Fruit yield per plant
ICO 216264	57.00	99.02	4.00	3.01	2.00	72.00	147.00	31.01	7.83	3.53	67.02**	2077.04
ICO 216794	59.02	102.04	4.00	3.00	2.00	76.02	163.03	43.00**	6.43	5.10	38.58	1655.58
ICO 241678	58.01	97.01	5.00	2.01	3.00	73.00	170.01	29.04	7.38	4.82	26.30	762.76
ICO 316294	61.02	109.02	4.01	3.00	3.00	80.00	180.00*	18.00	6.50	5.89*	88.10**	1585.85
ICO 329327	62.01	107.03	5.02	2.00	2.00	75.02	153.02	31.01	5.19	4.15	56.36	1745.32
ICO 334660	58.02	98.02	5.01	3.01	2.00	70.00*	168.03	20.02	4.58	4.63	71.82**	1436.03
ICO 334729	63.04	93.00	8.02	4.00	2.00	71.00	170.01	28.01	8.29	5.36	108.20**	3029.66**
ICO 336474	59.03	95.00	4.00	2.00	4.00**	74.01	149.02	36.00**	8.27	5.89*	80.76**	2905.25**
ICO 344674	62.01	111.00	3.02	4.00	2.00	76.02	162.03	35.00*	7.62	2.50	89.32**	3125.59**
ICO 354727	63.04	99.01	5.01	4.01	2.00	70.00*	173.00*	25.01	5.33	5.54	36.05	900.09
ICO 354749	60.02	108.04	3.00	4.00	2.00	72.00	180.00**	38.00**	8.41	4.10	21.02	798.02
ICO 355370	57.00	96.04	5.02	1.99	4.00**	73.00	167.01	23.01	7.95	4.89	21.08	483.03
ICO 361838	59.03	105.01	3.00	5.00	1.99	79.01	159.03	38.00**	8.73	4.71	61.67	2318.05**
ICO 373485	62.01	99.02	3.02	3.01	2.99	76.04	148.01	42.00**	15.29**	5.16	90.463**	3796.82**
ICO 374777	60.03	98.03	5.00	5.00	2.00	78.03	153.02	26.01	6.45	5.33	110.33**	2867.85**
ICO 382587	57.00	92.01	6.01	3.00	2.00	77.02	170.03	21.04	7.40	5.04	43.28	907.25
ICO 383119	59.02	105.02	5.00	5.00	5.01**	72.00	146.00	30.02	10.49*	5.34	46.76	1401.02
ICO 394902	62.01	115.00	4.02	2.01	2.00	71.00	167.01	38.00**	10.09*	4.90	71.39**	2709.40**
ICO 398820	61.03	89.00*	5.00	1.99	2.00	76.04	156.02	20.01	11.69**	7.49**	68.24**	1364.04
ICO 411485	59.02	108.01	3.99	2.01	2.02	75.01	149.03	40.00**	16.59**	6.88**	63.05*	2520.08**
ICO 422586	55.00	96.04	3.02	3.00	3.02	74.03	174.00	25.01	5.72	5.19	65.12*	1625.07
ICO 427008	57.00	109.02	3.02	4.01	2.00	78.03	162.01	18.00	6.48	5.67**	32.06	576.03
ICO 427029	63.01	93.00	4.01	2.00	3.07	79.02	177.00	40.00**	7.42	4.65	40.19	1604.08
ICO 545862	61.00	104.01	4.99	3.00	2.00	72.00	169.01	32.01	6.25	5.13	26.54	848.03
ICO 545871	59.01	96.03	5.99	4.99	2.08	81.01	167.03	43.00**	7.13	4.15	50.31	2162.98*
ICO 545916	62.03	89.00*	3.99	5.01	2.99	76.04	174.00*	26.03	7.45	5.99*	53.09	1378.03
Whitish blue and ripped brinjal	61.02	93.00	4.00	3.01	4.05	74.02	179.00**	19.02	619	6.88**	41.64	790.47
Venyutha brinjal	57.01	98.04	8.02**	2.00	2.01	72.00	166.02	24.04	6.42	5.87**	29.81	715.22
Namakkal brinjal	63.00	93.00	6.02	1.99	3.03	71.00	147.00	40.00**	12.19**	5.59	28.39	1132.05
Utha brinjal	56.0*	108.01	4.01	2.01	2.00	77.04	161.02	16.00	10.18**	4.50	21.06	336.09
Udumalai brinjal	58.03	97.04	4.00	4.01	2.00	75.03	169.01	30.02	13.08**	6.59**	81.35**	2439.04**
Udumalaisamba brinjal	61.02	96.02	5.04	5.01	2.1	78.01	155.02	35.00*	11.89**	4.45	77.92**	2595.14**

Table 3 contnued .....

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Genotypes/ Characters	Days to first flowering	Plant height	Number of branches per plant	Number of flowers per clusters	Number of fruits per clusters	Days to first harvest	Days to last harvest	Number of fruits per plant	Fruit lenght	Fruit breadth	Average fruit weight	Fruit yield per plant
Vellore mullukathiri	63.03	99.03	4.01	3.01	3.00	73.00	172.00*	39.00**	7.53	6.38**	61.20	2386.88**
Dindugal kathiri	65.00	101.01	5.00	3.01	2.00	78.02	16303	36.00**	12.88**	4.53	51.42	1850.47
Brinjal thorn	64.03	93.00	6.00	3.01	2.00	72.00	165.01	26.03	10.40*	5.98**	60.87	1580.83
Arkakusumakar	54.00**	98.04	4.04	5.01	2.00	80.00	167.02	18.00	7.00	3.30	34.06	612.07
CVK Sirukkaraisivappu	59.01	104.02	6.00	4.01	2.09	71.00	149.03	33.04	8.54	6.18**	61.54	2029.54
Udavai green brinjal	60.03	101.01	4.01	4.01	2.04	81.00	157.01	28.01	6.51	4.87	26.81	750.43
Pusa upkar	61.02	95.00	7.00**	5.01	3.00	73.00	160.03	41.00**	9.35	5.34	49.92	2045.90
BH-2	56.00*	98.04	4.00	3.01	2.00	72.00	176.00**	44.00**	8.82	4.16	71.31**	3137.22**
Utkalkeshari	64.02	99.03	5.04	5.01	2.00	76.01	163.02	41.00**	10.88*	5.79*	118.57**	4858.56**
Utkalijyoti	60.02	97.01	7.01**	4.01	2.00	78.03	148.03	30.03	6.96	6.28**	96.73**	2901.07**
JBH-3	62.03	98.04	8.03**	5.01	2.99	71.00	164.01	46.00**	11.88**	4.82	71.86**	3302.84**
VR-2	64.01	103.03	3.04	5.01	2.00	75.03	17.00**	45.00**	11.49**	7.09**	62.03	2790.06**
DMU-1	59.03	95.00	7.01**	4.01	3.00	76.02	165.03	29.02	9.04	5.68	41.22	1194.89
KKM-1	55.00*	98.03	4.00	4.99	2.00	74.01	145.00	36.00**	7.01	4.46	33.43	1202.47*
Punjab Sadaarhar	59.02	104.01	7.04**	4.01	2.00	79.04	170.01	28.03	13.98**	3.84	43.05	1204.03*
PBNP-1	62.03	93.00	3.01	2.01	3.00	80.00	165.00	18.00	11.99**	3.63	99.42**	1789.26*
PBNP-5	65.01	97.02	5.00	5.01	2.00	81.00	168.02	38.02	10.47**	4.64	88.36**	3355.46**
PBNP-6	57.00	102.01	8.00**	4.01	4.00**	78.01	171.01	18.00	15.09**	4.71	47.68	856.83

X_3) Number of branches per plant, X_4) Number of flowers per cluster, X_5) Number of fruits per cluster, X_6) Days to first harvest, X_7) Days to last harvest, X_8) Number of fruits per plant, X_9) Length of fruits, X_{10}) Breadth of fruits, X_{11}) Average fruit weight and X_{12}) Fruit yield per plant, on five plants per entry per replication.

Results and Discussion

Genetically diverse parents will have good combining ability resulting in high heterosis and release superior segregants in later generations. The present inquiry was formulated to quantify the extent of genetic diversity among 50 genotypes of brinjal (*S. melongena*), using Mahalonobis D^2 statistic, based on 12 yield and yield contributing traits. Genetic divergence studies revealed that 50 genotypes of brinjal were grouped into seven clusters based on their D^2 values. Among the seven clusters, cluster VII accommodated maximum of twenty one genotypes followed by cluster I of fourteen genotypes, followed by cluster III of five genotypes and by cluster IV of four genotype and finally two genotypes were accommodated in each clusters *viz.,* cluster II, IV and V.

The kind of genetic diversity found among the genotypes belonging to same geographic origin may be due to differences in adoption, selection criteria, and selection pressure in environmental conditions. The grouping of genotypes into so many clusters suggested the presence of high degree of diversity in the material evaluated. Earlier workers have also reported presence of substantial genetic diversity in brinjal (Quamruzzman *et al.*, 2009, Muniappan *et al.*, 2010 and Balaji, *et al.*, 2013). The highest intra-cluster distance was registered in cluster VII followed by cluster VI, cluster III and cluster I. Thus, the genotypes from those clusters had high degree of divergence that would produce more desirable segregants for achieving greater genetic advance. The least intra-cluster distance was revealed in

Table 4: Composition of brinjal genotypes in different clusters based on D^2 analysis embers on cluster.

Cluster Number	Name of the genotypes
I	ICO 216264, ICO 216794, ICO 241678, ICO 316294, ICO 329327, ICO 334660, ICO 334729, ICO 336474, ICO 344674, ICO 354727, ICO 354749, ICO 355370, ICO 361838 and KKM-1
II	PUSAUPKAR and DMU-1
III	ICO 373485, ICO 374777, ICO 382587, Udumalai Sama Kathari and PBNP-5
IV	Udumalai Brinjal and VR-2
V	CVK Sirukkarai Sivappu and UTKALJIYOTI
VI	ICO 383119, ICO 394902, ICO 422586 and Vellore Mullu Kathari
VII	ICO 398820, ICO 411485, ICO 427008, ICO 427029, ICO 545862, ICO 545871, ICO 545916, Whitish blue and ripped brinjal, Venyutha round brinjal, Namakkal brinjal, Utha brinjal, Dindigual kathari, Brinjal thorn, Arka kusumakar, Udavai green brinjal, BH-2, UTKALKESHARI, JBH-43, PUNJAB SADABAHAR, PBN-1 and PBNB-6

Table 5: Inter and intra cluster distance and inter and intra cluster D^2 value.

Cluster	I	II	III	IV	V	VI	VII
I	66.446 (4415.072)	59.174 (3501.619)	70.223 (4931.285)	71.497 (5111.751)	64.522 (4163.149)	68.179 (4648.375)	71.043 (5047.140)
II		26.209 (686.928)	56.664 (3210.816)	58.370 (3407.049)	49.611 (2461.204)	64.932 (4216.186)	58.888 (3467.793)
III			66.985 (4486.982)	65.308 (4265.106)	59.643 (3557.232)	75.545 (5707.113)	68.81 (4734.837)
IV				35.178 (1237.525)	59.362 (3523.796)	71.836 (5160.371)	68.363 (4673.503)
V					37.968 (1441.571)	70.082 (4911.484)	66.721 (4451.647)
VI						69.152 (4782.042)	75.805 (5746.429)
VII							71.071 (5051.065)

Table 6: Cluster mean of brinjal genotypes for different traits

Clusters	Days to first flowering	Plant height	No. of branches per plant	No. of flowers per clusters	No. of fruits per clusters	Days to first harvest	Days to last harvest	No. of fruits per plant	Fruit length	Fruit breadth	Average fruit weight	Fruit yield per plant
I	59.50	101.21	4.42	3.28	2.42	73.92	163.35	30.78	7.06	4.64	57.04	1716.00
II	59.99	95.00	7.00	4.50	2.99	74.50	162.50	35.00	9.15	5.45	45.55	1620.35
III	61.00	96.40	4.80	4.20	2.21	78.15	158.83	32.45	10.21	4.87	82.03	2724.47
IV	61.00	100.00	3.50	4.50	2.00	75.00	174.00	37.50	12.20	6.75	71.65	2614.50
V	59.50	100.49	6.50	4.00	2.00	74.50	148.49	31.50	7.70	6.15	79.10	2465.25
VI	59.75	103.75	4.00	3.25	3.25	72.50	164.74	33.00	8.39	5.40	61.05	2030.55
VII	60.09	98.47	5.04	3.33	2.42	76.09	165.14	29.57	9.81	5.11	51.35	1588.98

cluster II. Parallel findings were found by Golani *et al.*, (2002), Muniappan *et al.*, (2010) and Yadav *et al.*, (2008).

Highest inter cluster distance was found between cluster VI and VII followed by cluster III and VI, cluster IV and VII, cluster I and IV and the minimum inter distance were recorded between in cluster II and V indicating the wider genetic diversity among the genotypes between these clusters. This indicated that the genotypes in these clusters are having broad spectrum of genetic diversity and could very well be used in hybridization programme. Similar results were reported by Madhavi *et al.*, (2015) and Ravali *et al.*, (2017).

Table 7: Relative contribution of different characters of genetic divergence.

S. No.	Character	Percentage of contribution
1	Days to first flowering	01.01
2	Plant height	04.89
3	Number of ranches per plant	01.79
4	Number of flowers per clusters	02.53
5	Number of fruits per cluster	07.26
6	Days to first harvest	01.14
7	Days to last harvest	06.28
8	Number of fruits per plant	10.04
9	Fruit length	02.83
10	Fruit breadth	09.33
11	Average fruit weight	16.65
12	Fruit yield per plant	36.16
	Total	100.00

Cluster mean analysis revealed a wide range of variation for all the traits under this study. Cluster I and V had lowest cluster mean value for days to first flowering indicating that genotypes in these cluster had earliness in flowering while in cluster VII, later flowering was observed. Cluster II exhibited lowest cluster mean values for plant height whereas cluster VI had highest value. Hence, genotypes from cluster VI could be used in breeding for obtaining semi-dwarf segregants. Cluster II had maximum number of branches per plant, however, cluster IV had minimum number of branches per plant.

Number of flowers per cluster was found maximum in cluster II and IV, but, cluster VI had the minimum number of flowers per cluster. Thus, genotypes from cluster II and IV could be utilized in cross breeding programme for developing earliness in flowering but with more number of flowers per cluster. Cluster VI registered maximum number of fruits per cluster. Cluster V had the least number of fruits per cluster. Cluster III had the longest days to first harvest but cluster VI had the shortest days to harvest.

For days to last harvest cluster IV as it had maximum days to last harvest. Minimum days to last harvest were registered in cluster V from which genotypes could be used in developing long days to last harvest. Cluster IV had the highest cluster mean value of number of fruits per plant compared with cluster VII which had the least value. Cluster IV had maximum fruit length, however, cluster I had minimum fruit length. Cluster IV had the highest fruit breadth compared with cluster I which had the least value. Average fruit weight was observed with maximum in cluster III while cluster II was characterized with minimum average fruit weight. Cluster III had the highest cluster mean value of fruit yield per plant compared with cluster VII which had the least value. The indicated that none of the clusters had all the desirable characters. Almost the minimum and maximum cluster mean values were distributed in relatively distant cluster.

Cluster IV had desirable mean performance for the traits *viz.*, days to first flowering, plant height, number of flowers per cluster, days to last harvest, number of fruits per plant, fruit length, fruit breadth, average fruit weight and fruit yield per plant with mean values higher than cluster mean value. Cluster III, V, VI had the above mentioned similar traits and number of branches per plant for which the mean values were higher than the cluster mean value. Cluster II and VII had mean values higher than cluster mean value. Cluster I had mean values higher than cluster mean value for plant height. The findings of the present study suggested that inter crossing of genotypes from different clusters exhibiting good mean performance may be helpful for obtaining higher yield and thus, selection of more diverse parent for hybridization is believed to provide the chance of getting better heterosis and give broad spectrum of variability in segregating generation.

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